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THE EVOLUTION OF THE CEREBELLUM.

THE cerebellum has unquestionably given more trouble to anatomists than almost any other organ, and our present knowledge of its structure seems disproportionate to the labor expended. It is no discredit to the monumental works of Stilling, Meynert, Purkinje, Gerlach, and Kölliker to admit that scarcely a single tract connecting the cerebellum with other portions of the brain is traced with sufficient detail. Even the external configuration of the cerebellum in lower animals has many lessons for us which may be useful in the interpretation of the human organ.

The cerebellum is subject to a greater range of variation than any other organ of the brain. From being practically absent, as in amphibia, to preponderating over all other segments of the brain in some fishes, there is every gradation in development. It becomes obvious from a brief study of the relative development of the regions of the encephalon that the cerebellum does not vary in proportion to the intelligence; that, in other words, it cannot be employed as a criterion of the position of the animal in the scheme of classification as can the cerebrum. Although not available for taxonomic purposes, these variations are none the less interesting from the clew which they may afford to the functions and laws of development of this and associated organs.

In the March number of the *Journal of Comparative Neurology* the writer called attention to the architectural modifications of the cerebellum in reptiles, and the progressive evolution of the organ in the several groups, as well as the resemblance of this course of evolution to a peculiar and apparently undescribed law of development of the cerebellum in mammals.

The cerebellum is peculiarly mobile, considered architecturally, by reason of its mode of attachment to the axis of the brain. It is morphologically the roof of the fourth ventricle. Both before and behind it is connected with the doral surface of the brain-tube by a velum, or thinned lamina, devoid of nervous matter, and extensively folded and combined with vascular sinuses to form a nutritive organ, the plexus choroideus (metaplexus and mesaplexus). The velum posterior extends about the sides of the cerebellum also, so that rigidity is given to that organ only by the several fibre-bundles or peduncles of the cerebellum which connect it laterally with other regions. Thus, however large and heavy it may be, the cerebellum is supported solely by a lateral axis entering at the base. There is really nothing to prevent the most extensive rotations or foldings of the body in all directions except laterally.

The progressive development of this region is nowhere more conveniently illustrated than in the reptiles. Taking the transverse bar which constitutes the cerebellar rudiment in amphibians as a point of departure, we first encounter a leaf-like body with the ventricular half of the substance composed of granular material. The tracts are chiefly scattered in the dorsal white layer. In the serpents this flap is flexed so as to form a hood-like body. The flexture is due to the so-called pons-flexture of the whole medulla. The flexture is more pronounced in turtles, and results in a complete roof over the fourth ventricle, which may be considerably arched. It is obvious that there must be a limit to the development along this line. In higher reptiles, whose motions are more active and require more accurate co-ordination, the increase in size necessary to supply sufficient nervous matter renders necessary a complete eversion of the leaf-like organ. In the lizards the lamina is folded forward in such a way as to make a double roof over the ventricle, bringing the granular layer, with its neuro-epithelium dorsad, in the superior layer, while it faces ventrad (toward the ventricle) in the ventral lamina. In the alligators the development is more extensive, and results in a horizontally placed hollow cone, with the apex directed caudad, and attached by the ventral portion of its base to the brain base. The outside of the cone is clothed with epithelium, while the inside is the morphologically ectal surface. Of course, in this description the thin velum which originally connected the edges of the leaf has been disregarded. This eversion of the cerebellum is of the highest importance in preparing us to understand the origin of the cellular elements in the human cerebrum. Before alluding to this subject we may pass in review a few illustrations of cerebellar architectonic from other classes of vertebrates.

In fishes the range of variation is remarkable, in so far that it may render the brains of closely allied genera very dissimilar in appearance. The characteristics of the fish cerebellum, which serves to distinctly separate it from all other classes of mammals, is the development of a second portion of the organ in front of the valve of Vieussens, which is the morphological anterior (cephalad) margin of the cerebellum in other cases. The relatively large amount of cerebellar substance required by active fishes, and the lack of definite walls to the ecephalic cavity, result in curious folds on a large scale and simple plan. The forward fold in front of the valve, which the writer has termed volvula, from its purse-like form, often completely fills the cavity of optic lobes, and in some cases (as the black-horse, *Cycleptus*), actually pries the two halves of the roof or tectum of that organ apart, and protrudes upon the dorsal surface with only the membranous velum tecti above it. The moon-eye, *Hyodon*, is the most reptilian of the osseous fishes so far examined, and in this case the cerebellum proper is a simple sac extending caudad: there is no external evidence of a volvula or of lateral lobes or "bursa." Sections show,